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Anatomy and micro morphological studies on *Calceolaria mexicana* (Calceolariaceae) from Western Ghats, India

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Abstract

Calceolaria mexicana is a wild variety that has been cultivated and naturalized in Karnataka. Exploration of this species with the study of root, stem and leaf anatomy with pollen and seed morphometry for the first time in India with the micro-morphological analysis.

Keywords: *Multicellular trichomes, Pollen morphometry, Seed morphometry, Slipper flower.*

Introduction

Calceolariaceae Raf. ex Olmstead family records two genera (*Calceolaria* L. and *Jovellana* Ruiz & Pav.) across Subtropical & South America to Falkland Islands and also New Zealand, Chile. *Calceolaria* L. records 269 species across the world. *Jovellana* Ruiz & Pav. records four species across the world (POWO KEW, 2025). India records three (*Calceolaria glacialis* Wedd., *Calceolaria mexicana* Benth., *Calceolaria tripartita* Ruiz & Pav.) species has been cultivated and are naturalized to native environment (POWO KEW, 2025; EFI, 2025). Karnataka records 2 *Calceolaria* species (*Calceolaria mexicana* Benth.) from Chikkamagluru, Kodagu, Mysore (Sanjappa & Sringeswara, 2019). Ravi Kumar *et al.*, (2021) reported *Calceolaria mexicana* Benth. in Orbanchaeae family other than Calceolariaceae.

Material and Methods

Study Area: Chikkamagalur, is famous for hill station with highest peak an coffee plantations. It is situated at the Central Western Ghats. Mullayyanagiri is located Kaimera region of the Western Ghats. It is the highest peak in Karnataka. The hill reaches 1,930 meters (6,330 ft.). The coordinates - 13°23'27.5"N 75°43'17 E/ 13.390972 ° N 75.72139° E. Baba Budangiri hill is situated in the Chikkamagalur district of Karnataka. The hill is 1,895m (6,217ft), coordinates 13.4229°N , 75.7704° E. It is famous for the Iron ore mining.

Study area & Digitalization of Herbarium: The collect the species from Mullyengiri & Bababudangiri of Chikmagulur district in the month of September. The plant was identified by using local flora (Gamble & Fischer, 1921; Sanjappa & Sringeswara, 2019). The herbarium method, collecting, pressing, and drying plant specimens. To prevent fungal or insects damage, specimens are often poisoned using chemicals like Mercuric chloride (2%). Dried plants are mounted on herbarium sheets with proper labels detailing species name, locality, date, and collector. These sheets are stored systematically in controlled conditions. They were submitted to the Herbarium of Karnataka Science College (HKCD) for future references (Dey, 2026).

Dissection & Photo plate:
The specimens were dissected under a stereo microscope for detailed observation. Photographs were taken in OnePlus norde at 1x zoom. Photo plates were made by arranging clear images in a grid by using Adobe Photoshop software CS3-2024, which was used preparation of photoplate. Images are cropped, aligned with scale and labelled. The final plate is saved in high resolution (JPEG)

Anatomical studies:
Collected stem samples were stored in water for one day, washed in 100 % alcohol, and sectioned and stained with safranin stain and observed under binocular microscope, recorded the characters with photographs. Ovary anatomy was selected small ovary which is slightly maturing, sectioned and observed under microscope with safranin stain (Gulaguli, *et al.*, 2025).

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Micro (Pollen) and Macroscopic (Seed) analysis: Pollens were washed with 100% alcohol and mounted on carbon stub using paint brush with damaging them. Seeds were mounted and spread on carbon stubs using a fine needle or brush. The mounted samples were coated with gold using a mini sputter coater for 30 seconds at approximately 70 m Torr pressure. After sputter coating, the stubs were examined under a scanning electron microscope for microphotography, following the protocol followed by Shreyas & Kotresha (2024) and Deshi *et al.,* (2025).

Results

Taxonomic treatment

Calceolaria mexicana Benth. Pl. Hartw.: 47 (1840); B. D. Sharma et al., Fl. Karnataka Anal. 189. 1984; *Fagelia mexicana* (Benth.) Kuntze, Revis. Gen. Pl. 2: 459.189. Figure 01 & 02

Erect herbs, 30-50 cm tall; Stem green erect, terete, ridged, weak sometimes, hairs present. Leaves 3-6 × 3 cm, pinnatisect, 1-3 pairs, acute lateral lobes, elliptic or lanceolate, serrate margin, occasionally incised laciniate, gland-dotted hairs, beneath pale green; petiole present; Inflorescence axillary pedicels, 6-12 flowered cymes; bracts, present; sepals 6 × 2 mm, , green, ovate, acuminate, denticulate, ciliate with gland- dotted hairs; corolla yellow, glabrous, the upper lip 3 × 3 mm wide, hooded, which holds the anthers, the lower lip 10-20 × 6-15 mm, projecting, shoe like; anthers 3 mm long, the upper lobe fertile, the lower lobe sterile, reduced to a knob under the hood of the corolla, the connective elongated, slender and sigmoid, occasionally flattened, 1.2-2.0 mm long, the filament 0.5 mm long; style 1.5-2.0 mm long, curved. Capsule widely conical, 6-8 mm long, glandular pilose.

Flowers: August-September; Fruits: October onwards

Species examined: Sityalgiri, Chikkamagaluru; **Collector no. & Date:** 02 & (HKSCD) Figure 04.

Distribution: Karnataka (Chamarajanagar, Chikkamagaluru, Kodagu, Shivamogga), Peninsular India; native to Mexico. Local/Common/Vernacular names: Lady's purse, Pocketbook flower, Slipper flower, Slipperwort (English).

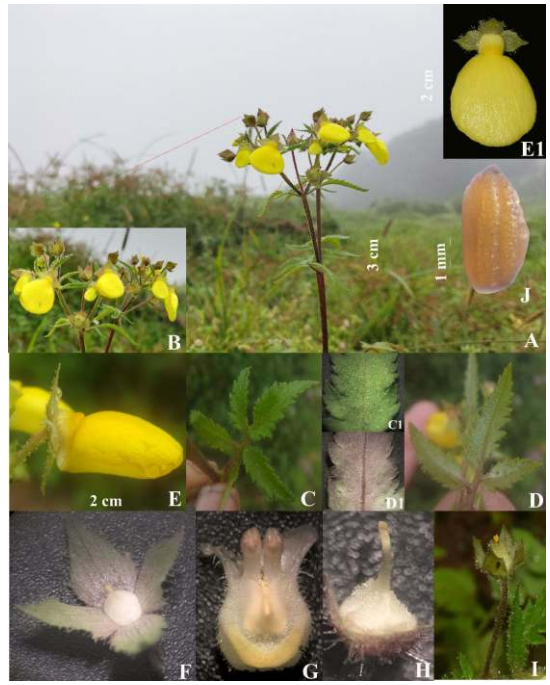

Figure 01: *Morphology of Calceolaria tripartita Ruiz & Pav.* ***A.*** *Habit;* ***B.*** *Inflorescence;* ***C.*** *Dorsal leaf;* ***D.*** *Ventral leaf;* ***E.*** *Side view of flower;* ***E1.*** *Front view of flower;* ***F.*** *Calyx;* ***G.*** *Anthers;* ***H.*** *Ovary with stigma;* ***I.*** *Fruit;* ***J.*** *Seed (Photography by Dr. Shreyas Betageri)*

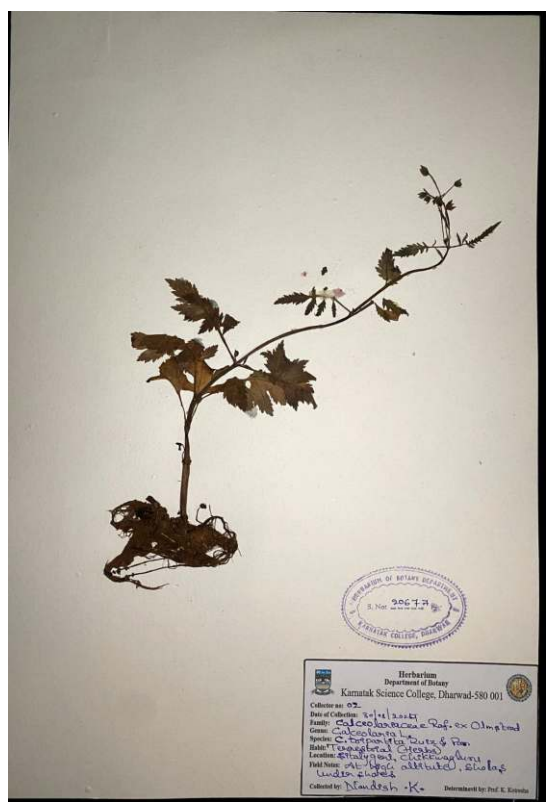

Figure 02: *Herbarium submitted to Herbarium of Karnatak Science college, Dharwad*

Anatomy of *Calceolaria mexicana* Benth.:

Roots (Figure 03):

Epidermis of single layered without cuticle. Absence of hairs or secondary roots on the epidermis. Cortex is made up to two types of cells. One layer with small cuboidal shape cells next to epidermis. After that large pentagonal cells densely packed with 3-5 layers. Endodermis is 1-2 layers elongated pointed shaped cells. Vascular bundle is ring form with protoxylem towards outside (endodermis) and metaxyelm at the innerside (Pith). Pith is small at the center with spherical cells.

Stem (Figure 04):

Stem is circular with trichomes. Trichome is pin head long with two celled. Epidermis is single layer with cuboidal cells without cuticle. Cortex is 3-4 layered made up of collenchyma and chlorenchyma cells arranged tightly. Endodermis is single layered elongated cells. Followed by endodermis vascular ring is present. Phloem and xylem well developed. Metaxylem at center. Pith is very large, well developed with penta, hexa and circular parenchyma cells.

Leaf (Figure 05):

Leaf is made up of upper and lower epidermis which is single layered. Both layers contain multicellular, gland tipped trichomes. Mesophyll is divided in to two types that is palisade and spongy. Palisade parenchyma are well packed without any air gaps. Spongy parenchyma is loosely covering. Phloem is surrounded by xylem. Stomata is aniscocytic type with irregular amoeboid.

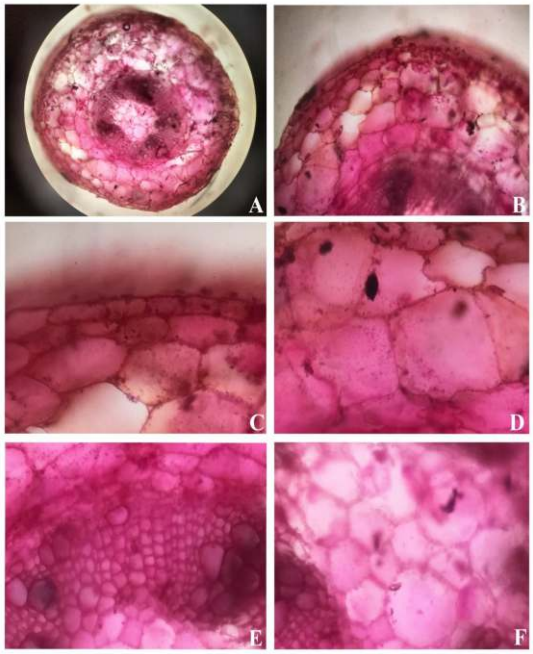

Figure 03: *Calceolaria tripartita Ruiz & Pav. A. T. S. of root; B. Enlarged section of T. S.; C. Epidermis showing cortex region; D. Cortex region; E. Vascular bundle; F. Pith region (Photography by Dr. Shreyas Betageri)*

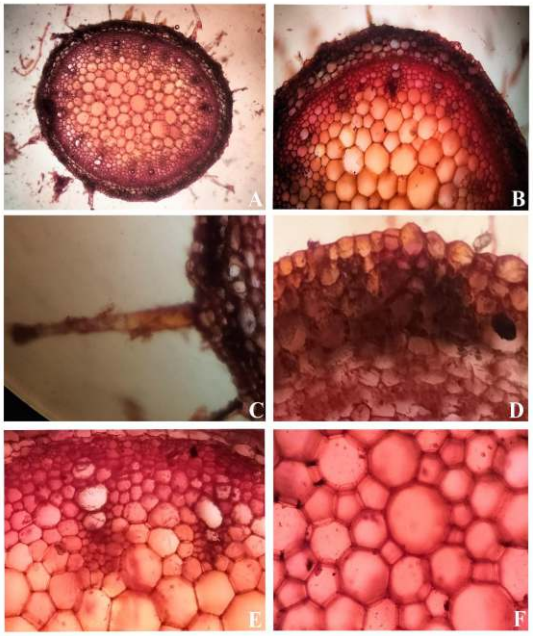

Figure 04: *Calceolaria tripartita Ruiz & Pav. A. T. S. of Stem; B. Enlarged section of T. S.; C. Epidermal multicellular trichome; D. Cortex region; E. Vascular bundle; F. Pith region (Photography by Dr. Shreyas Betageri)*

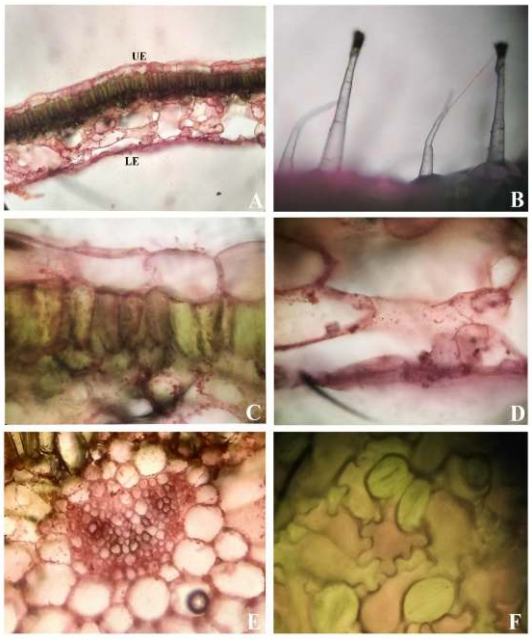

Figure 05: *Calceolaria tripartita Ruiz & Pav. A. T. S. of leaf; B. Upper epidermal multicellular trichome; C. Palaside mesophyll towards upper side; D. Spongy mesophyll towards lower side; E. Vascular bundle; F. Stomata with irregular epidermal cell (Photography by Dr. Shreyas Betageri)*

Pollen morphometry

Pollens are spherical as per polar view and oblate shape as per the equatorial view. Pollen is tri-colpate, colpi length is 13.21 µm and breadth is 2.8 µm. Length of pollen in equatorial plane is 15.42 µm and breadth of pollen is 14.2 µm. Length of pollen at polar view is 13.8 µm and breadth of pollen is 13.25 µm. Surface of pollen is reticulate with lumen inside with thick wall (Figure 06 & Table 1).

Seed morphometry

Seeds are many in single fruit. Color of a seed is Orange-yellow. Seed shape is Urceolate shape with acute ends (Figure 06 & Table 1).

Table 1: Showing the parameters of pollen and seed morphometry:

Scientific name	Color	Shape of pollen & seed	L (µm)	B (µm)	L/B (µm)	Shape of testa cell	L (nm)	B (nm)	L/B (nm)	Aperture L (µm)	Aperture B (µm)
Pollen	White	Ellipsoid	14.45	14.28	1.01	Reticulate with lumen and muri	650.1	550.3	1.18	12.73	2.745
	Color	**Shape of pollen & seed**	**L (µm)**	**B (µm)**	**L/B (µm)**	**Shape of testa cell**	**TL (nm)**	**TB (nm)**	**L/B (nm)**	**Ridge L(µm)**	**Ridge B(µm)**
Seed	Orange-yellow	Urceolate shape with acute ends	589.2	370.7	1.59	Favolate with thin wall and irregular ameboid testa cells	65.93	35.11	1.87	432.2	173.4

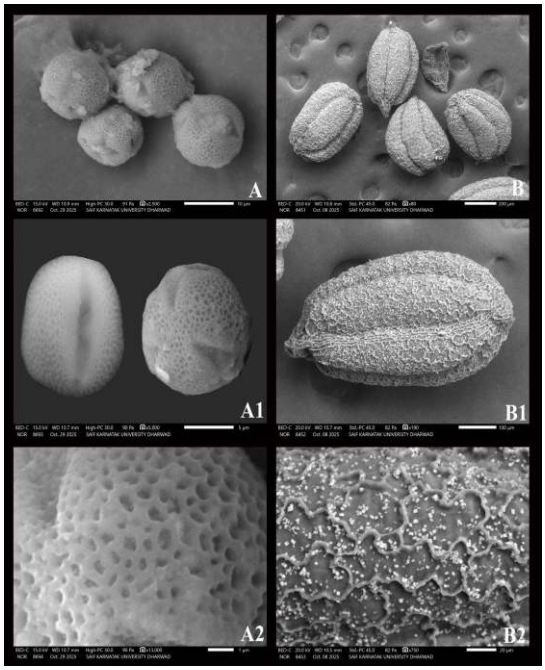

Figure 06: Calceolaria tripartita Ruiz & Pav. A. Pollen clump; A1. Equatorial and polar view; A2. Ornamentation of pollen; B. Seeds; B1. Single seed; B2. Testa cells of seed

References

1. DESHI, S., BETAGERI, S., PATGAR, V.G. AND K. KOTRESHA 2025. Achene morphology of some genera of Cyperaceae Juss. in Karnataka. *Species*. 26 (78): e41s3181. DOI: https://doi.org/10.54905/disssi.v26i78.e41s3181.
2. EFI 2025. Eflora of India, Database of Plants if Indian Subcontinent. https://efloraofindia.com/efi/calceolaria-tripartita/ [Retrieved 27 January 2026].
3. DEY. M. 2026. Training Course on Herbarium Techniques and Methodology. ENVIS Centre on Floral Diversity Botanical Survey of India. 1-38.
4. NAYAR, T. S., RASIYA BEEGAM, A. AND M. SIBI 2014. *Flowering Plants of Western Ghats, India*. Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Kerala. 840.
5. POWO (2026). "Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Published on the Internet; https://powo.science.kew.org/ [Retrieved 27 Januray 2026]"
6. RASHMI GULAGULI, SHREYAS BETAGERI, VANAJA G. PATGAR AND K. KOTRESHA (2025). Anatomical studies (Stem & Ovary) of Genus *Datura* L. (Solanaceae) in Karnataka, India. *Journal of Plant biota*. 77-81. https://doi.org/10.51470/JPB.2025.4.1.77
7. RAVIKUMAR, K., TANGAVELOU, A. C. AND N. PAGE 2021. *Seed Plants of Karnataka, India: A Concise Dictionary*. FRLHT-TDU. Bangalore. 543.
8. SANAJAPPA, M. AND A. N. SRINGESWARA 2019. Flora of Karnataka, a Checklist. Vol. II. Gymnosperms and Angiosperms. Karnataka Biodiversity Board, Bangalore. 206.
9. SHREYAS BETAGERI AND KATRAHALLI KOTRESHA 2024. Seed morphometric with Embryo diversity of wild orchids in North Karnataka. *Journal of Diversity studies* 3(2): 39-50.